

## Bending pliers for perforated bone plates and bending-pliers system

### TECHNICAL FIELD

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The invention relates to bending pliers for perforated bone plates and to a bending-pliers system comprising bending pliers and one or more bone plates.

### BACKGROUND OF THE INVENTION

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In surgical operations in the mid-face region for example, perforated bone plates are generally used to fix bones or bone fragments. It is frequently necessary here to adapt a bone plate to the contour of a bone or bone fragment. Such adaptation can be effected either by manual bending of the bone plate or by means of suitable bending pliers or a suitable pair of bending pliers. Thus, it is known to receive a bone plate with two separate bending pliers and to deform it by a relative movement between the two bending pliers.

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The object on which the invention is based is to specify multifunctional bending pliers.

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### SUMMARY OF THE INVENTION

This object is achieved according to the invention by bending pliers for perforated bone plates which comprise two jaws movable relative to one another. A first jaw in the form of a receiving jaw has two spaced-apart receptacles with an axial extent for insertion into holes of a bone plate to be received. A second jaw in the form of a pressure-exerting jaw comprises a pressure-exerting (or counter-bearing) element which, when the bending pliers are actuated, cooperates with a received bone plate in a region between the two receptacles. The receptacles have an outside diameter

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which is variable in their axial extent in order to cooperate with different hole types, in particular different hole diameters.

5 The reception of the different bone plates preferably takes place in a form-fitting manner. For this purpose, the receptacles have, for example, an expediently circular or elliptical cross-section matched to the hole shape of the individual bone plates or, for example, a cross-section in the shape of an external hexagon. Other cross-sectional shapes are also conceivable, provided that a secure reception of the bone plates is ensured.

10 According to a preferred embodiment of the invention, the receptacles have an outside diameter which is smallest at the free ends of the receptacles and increases continuously in the direction of a bearing arrangement of the two jaws. The increase in the outside diameter preferably takes place in a stepped manner or else constantly  
15 in the mathematical sense, i.e. without bends. In the case of a stepped configuration of the outside diameter, preferably between two and five steps are provided. In the case of a constantly increasing outside diameter, the receptacles are preferably of conical design.

20 The receptacle pair can extend in different directions in relation to a pressure-exerting direction, i.e. in relation to that direction in which the pressure-exerting element transmits a force into a received bone plate. According to a first version of the invention, the receptacles extend substantially perpendicularly to the pressure-exerting direction. In this configuration, bending of a received bone plate takes place  
25 within the hole plane. According to a second version, the receptacles extend substantially parallel to the pressure-exerting direction. This means that a received bone plate is deformed out of the hole plane.

30 The pressure-exerting element, which transmits the pressure-exerting force into the bone plate, can have various designs. A peg-shaped pressure-exerting element with, for example, a cylindrical or conical shape is expedient. The cross-section of the

pressure-exerting element can, to a very large degree, be freely chosen. Circular or drop-shaped cross-sections have proved advantageous in practice.

5 The arrangement of a peg-shaped pressure-exerting element in relation to the receptacles is chosen according to whether a received plate is to be bent in the hole plane or out of the hole plane. In the first case, in a pressure-exerting position of the bending pliers, i.e. in a position in which a pressure-exerting force can be transmitted into the bone plate, the receptacles and the peg-shaped pressure-exerting element run substantially parallel to one another. In the second case, i.e. when the bone  
10 plate is to be deformed out of the hole plane, the receptacle pair and the peg-shaped pressure-exerting element extend approximately perpendicularly to one another. Expediently, the axial extent of the receptacles corresponds approximately to the axial extent of the pressure-exerting element, i.e. the free ends of these components lie approximately on one plane.

15 A bending-pliers system according to the invention comprises, besides the bending pliers already explained, at least two types of bone plates, each with a different hole type. Thus, a first bone-plate type can have, for example, a hole diameter in the range between approximately 1 and 3 mm and a second bone-plate type can have a  
20 hole diameter of between approximately 3 and 6 mm. Additionally or alternatively, the bending-pliers system could have a bone plate with a hole type which differs from section to section.

25 The one or more bone plates of the bending-pliers system according to the invention can have a planar or a nonplanar form. Nonplanar bone plates with a single row of holes are preferred.

30 In principle, the distances between two holes can be freely chosen. Distances of between approximately 2 and 8 mm have proved expedient. It is particularly advantageous if the distances between each two holes of different types of bone plates are equal or are an integral multiple of one another. In the case of a bone

plate with a hole type which differs from section to section, the distance between each two holes of a first region should be equal to or an integral multiple of the distance between each two holes of a second region.

5     **BRIEF DESCRIPTION OF THE DRAWINGS**

Further advantages and configurations of the invention emerge from the following description of preferred exemplary embodiments and the figures, in which:

- 10     Fig. 1           shows a perspective view of bending pliers according to the invention;
- Fig. 2           shows an enlarged, perspective view of the two cooperating jaws of the bending pliers illustrated in Fig. 1;
- 15     Fig. 3           shows a perspective view of the region illustrated in Fig. 2 from another viewing angle;
- Fig. 4           shows the bending of a bone plate with a small hole diameter using the bending pliers according to Fig. 1;
- 20     Fig. 5           shows the bending of a bone plate with a large hole diameter using the bending pliers according to Fig. 1; and
- Fig. 6           shows the bending pliers according to Fig. 1 with two different bone-plate types.
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**DESCRIPTION OF A PREFERRED EMBODIMENT**

30     Embodiments of bending pliers according to the invention and of a bending-pliers system according to the invention are described hereinbelow. In this particular example, the bending-pliers system according to the invention comprises two linear bone-plate types, each with a different hole diameter. The bending-pliers system

could of course also comprise further or other bone-plate types or a single bone plate with regionally different hole diameters. Moreover, it should be noted that the receiving pegs of the bending pliers according to the invention described hereinbelow could be shaped differently than explained in the exemplary embodiment.

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Fig. 1 shows a perspective overall view of bending pliers 10 according to the invention. The bending pliers 10 comprise at one end two handles 12, 14 which have a common bearing arrangement 16. On the side of the bearing arrangement 16 opposite the handles 12, 14, the bending pliers 10 have two jaws 18, 20 movable relative to one another.

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The jaw 18 functions as a receiving jaw for bone plates and is designed integrally with the handle 12. The jaw 20 functions as a pressure-exerting jaw and is designed integrally with the other handle 14. As can be seen in Fig. 1, the receiving jaw 18 has two receiving limbs 22, 24 spaced along an axis of rotation defined by the bearing arrangement 16. The pressure-exerting jaw 20 is arranged in a region between these two receiving limbs 22, 24. This means that, when the bending pliers 10 are actuated, the pressure-exerting jaw 20 moves between the two receiving limbs 22, 24.

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In Fig. 2, the front end of the bending pliers according to the invention as shown in Fig. 1 is illustrated in enlarged form. Clearly visible are the two receptacles 26, 28 of the receiving jaw 18 which are peg-shaped in this particular example. A first receiving peg 26 forms an extension of the receiving limb 22 on the left in Fig. 2 and a second receiving peg 28 forms an extension of the receiving limb 24 on the right in Fig. 2. The two receiving pegs 26, 28 are thus carried by different receiving limbs 22, 24 and are consequently offset from one another (as are the receiving limbs 22, 24) in the direction of an axis of rotation defined by the bearing arrangement 16. The two receiving pegs 26, 28 are mutually spaced by approximately 5 mm.

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Starting from a free end, facing away from the bearing arrangement 16, each of the two receiving pegs 26, 28 has a continuously increasing outside diameter. In the particular example illustrated in Fig. 2, the outside diameter of each of the two receiving pegs 26, 28 increases in a stepped manner. To be more precise, each of the receiving pegs 26, 28 comprises two cylindrical regions 30, 32, 34, 36 of different outside diameter. The outside diameter of the front cylindrical region 30 (on the left in Fig. 2) of the receiving peg 28 corresponds to the outside diameter of the front cylindrical region 34 of the receiving peg 26. The same applies to the respective outside diameters of the rear cylindrical regions 32, 36 (on the right in Fig. 2).

In a departure from the situation illustrated in Fig. 2, the receiving pegs 26, 28 could also have a constantly (e.g. conically) increasing outside diameter.

The pressure-exerting jaw 20 has at its front end a cylindrical pressure-exerting element 40 with a drop-shaped cross-section. In the illustration according to Fig. 2, the pressure-exerting element 40 runs substantially parallel to the two receiving pegs 26, 28 of the receiving jaw 18. This means that the receiving pegs 26, 28 extend substantially perpendicularly to a pressure-exerting direction defined by the pressure-exerting element 40. As will become clear from the following statements, this means that the bending pliers 10 of the exemplary embodiment permits the deformation of a received bone plate in the hole plane.

If bending of a bone plate out of the hole plane were to be necessary, the bending pliers illustrated in Fig. 1 would have to be modified slightly. In this case, the receiving pegs 26, 28 would have to be rotated 90° clockwise in Fig. 2. For this purpose, a corresponding mechanism which permits a change of the position of the receiving pegs 26, 28 could be provided. As an alternative to this, it would be possible to arrange the receiving pegs 26, 28, for example, on the free surfaces 42, 44 of the receiving limbs 22, 24 in such a way that they are upright in Fig. 2. In this case, it would be additionally necessary to displace the pressure-exerting element 14 slightly to the right in Fig. 2.

Fig. 3 shows a view of the bending pliers 10 according to the invention similar to the view of Fig. 2 but from another viewing angle.

5 Fig. 4 shows the bending pliers 10 according to Figs. 1 to 3 with a received linear bone plate 50 of a first type. The bone plate 50 has a plurality of linearly arranged holes 52 of a first diameter. The diameter of the holes 52 is chosen to be slightly greater than the outside diameter of the front cylindrical regions 30, 34 of the receiving pegs 26, 28. In addition, the centre-to-centre distance of two adjacent  
10 holes of the bone plate 50 corresponds to the centre-to-centre distance of the two receiving pegs 26, 28.

The bone plate 52 can be pushed onto the front cylindrical regions 30, 34 until the bone plate 52 comes to bear against an end face, facing the bone plate 52, of the  
15 rear cylindrical regions 32, 36 of greater diameter (the cylindrical region 36 of the receiving peg 26 is concealed in Fig. 4 by the bone plate 50).

It can be clearly seen from Fig. 4 that, when the bending pliers 10 are actuated, the pressure-exerting element 40 cooperates with the received bone plate 50 in a region  
20 between the two receiving pegs 26, 28. This cooperation takes place in a pressure-exerting direction indicated by the arrow A. The pressure-exerting direction is perpendicular to the axial extent of the receiving pegs 26, 28 and to that plane in which the holes 52 of the bone plate 50 are arranged. When the bending pliers 10 are actuated, the bone plate 50 is therefore deformed in the hole plane. This means  
25 that the holes of the deformed bone plate lie in the same plane as the holes of the bone plate before deformation.

Fig. 5 shows a view similar to Fig. 4. In the case illustrated in Fig. 5, the receiving pegs 26, 28 of the bending pliers 10 receive a linear bone plate 54 of a second type.  
30 The bone plate 54 of the second type has a plurality of holes 56 with a greater diameter than the holes 52 of the bone plate 50 of the first type illustrated in Fig. 4.

To be more precise, the holes 54 have a diameter which is slightly greater than the outside diameter of the rear cylindrical regions 32, 36 of the receiving pegs 26, 28. The centre-to-centre hole distance of the bone plate 54 corresponds to the centre-to-centre hole distance of the bone plate 50 according to Fig. 4. The bone plate 54 can  
5 be pushed onto the rear cylindrical regions 32, 36 until the rear side of the bone plate 54 comes to bear against the end faces 60, 62 of the receiving limbs 22, 24 illustrated in Fig. 3.

Fig. 6 shows a view of the bending pliers 10 similar to Figs. 4 and 5. In the case  
10 illustrated in Fig. 6, the receiving pegs 26, 28 receive the bone plate 50 according to Fig. 4 and at the same time the bone plate 54 according to Fig. 5. This means that the two bone plates 50, 54 can be deformed in a single working step and to the same extent.

15 From the foregoing explanations, it has become clear that the bending pliers 10 according to the invention can be used to deform bone plates of different hole diameters. A change of bending pliers during a surgical operation can thereby be avoided in many cases. In addition, the bending pliers according to the invention allow the simultaneous bending of bone plates of different hole diameter.

20 The above-described embodiment of the invention is intended to be an example of the present invention, and alterations and modifications may be effected thereto, by those of ordinary skills in the art, without departing from the scope of the invention which is defined by the claims appended hereto.